COMPLICATIONS USING THE SEIDEL INTRAMEDULLARY HUMERAL NAIL : OUTCOME IN 31 PATIENTS

H. SVEND-HANSEN [1], M. SKETTRUP [1], M. W. RATHCKE [2]

Thirty-one patients with humeral shaft fractures were operated using the Seidel intramedullary humeral nail. Three categories of patients entered the study : 6 with pathological fractures, 7 with nonunion and 18 with severely displaced fractures. The operation could be considered a partial success only in the pathological fractures. The failure rate and complication rate were very high. Both complications not specific for the nail and some directly related to it were encountered. The latter consisted in loss of both proximal and distal fixation and refractures occurring at the distal end of the nail several weeks after surgery. In consequence we have discontinued using the nail.

Keywords : humeral fractures ; intramedullary nailing ; Seidel ; complications.
Mots-clés : fractures de l'humérus ; enclouage médullaire ; Seidel ; complications.

INTRODUCTION

Fractures of the humeral diaphysis can normally be treated by conservative means. For years we have used the splinting described by Sarmiento *et al.* (11). Special fractures, however, sometimes require operative treatment. These fractures can be divided into three categories : nonunions, pathological fractures and severely displaced fractures with no bone contact. Fixation with plate and screws has been widely used, but often with the risk of damaging the radial nerve and the necessity of using a long incision. We decided prospectively to let these three types of patients enter the investigation, and this report presents our results using the Seidel nail over a period of five years.

MATERIAL AND METHODS

The Seidel nail was used in 31 patients for three types of indications : pathological fractures (6 patients), nonunion (7 patients) and severely displaced fractures (18 patients). None of the patients had had previous surgery. The nail was used for five years, and we discontinued its use in September 1995. Twenty-two patients were female, 9 male. The age range was 25 to 92 years, mean 65 years. Follow-up was from 3 to 25 months, mean 11 months. Ten patients died during the investigation, including all the patients with pathological fractures. Twenty patients were reexamined and scored according to the Neer score (5). The patient's own assessment of the result was recorded at the same time.

We used a high lateral deltoid-splitting incision. The entry point of the nail in all cases was the one described by Seidel on top of the humeral head.

The supraspinatus tendon was identified and the humerus was opened with a pointed awl under image intensifier visualization A9-mm nail was used and reaming was performed to the same diameter. If no expansion of the distal flanges was obtained, the nail was removed and overreamed by 0.5 mm. This occurred in six cases with narrow medullary canals. Correct expansion of the nail was ensured using an x ray image intensifier during the tightening procedure.

We never tried to introduce the nail without reaming. We did not overream by more than 0.5 mm because we risked thinning the cortices too much. All nails were locked both distally and proximally. We used the

[1] Department of Orthopedic Surgery, Helsingør Hospital, DK-3000 Helsingør, Denmark.
[2] Department of Orthopedic Surgery, Sundby Hospital, DK-2300 Copenhagen, Denmark.
Correspondence and reprints : H. Svend-Hansen, Helsingør Hospital, DK-3000 Helsingør, Denmark.

longest nail possible in order to obtain the highest degree of stability. Postoperatively no external support was used. We encouraged free shoulder and elbow exercises from the first day.

RESULTS

Pathological fractures :

All 6 patients were pain-free until they eventually died from the underlying disease. None of the fractures healed. We did not use curettage of the metastatic fracture or cement filling. Three of the patients died within 3 months, while none of the patients lived for more than 6 months after the operation.

Nonunions :

All 7 patients had bone grafting at operation. Abundant autogenous cancellous bone was used in all cases. Only 3 fractures healed. The 4 patients with nonunions that did not heal all had loosening of the nail and loss of fixation due to unscrewing of the distal expansion bolt, despite the fact that postoperative x rays had shown correct expansion of the nail flanges. A deep infection occurred in one of these patients.

Severely displaced fractures :

All the fractures healed, but in two cases a refracture occurred distally to the nail, both 4 weeks after surgery. During the operations no fractures were observed and no fractures appeared on the immediate postoperative x rays.

Both fractures occurred in patients with narrow bone canals, the cortices being thinned by the reaming which created a weak spot in the bone just distally to the nail between the supported and unsupported part of the humerus. One of the fractures healed by conservative means ; the other was reoperated using another intramedullary nail introduced distally.

We recorded many complications as shown in table I.

Table I. — Complications in 31 patients

Loss of proximal fixation	2
Loosening of the distal expansion bolt	10
Impingement of the rotator cuff	8
Refracture distal to the nail	2
Deep infection	1
Radial nerve palsy	1
Supraspinatus lesion	1
Axillary nerve lesion	1

Eleven out of 18 patients with severely displaced fractures had one or more of these complications. Ten had loosening of the distal expansion bolt, and in two cases the proximal screws lost their grip. In both cases only one screw had been used, as the most proximal screw could not be tightened.

Loosening of the distal expansion bolt was evident after 4 weeks in 6 patients and after 8 weeks in 4 patients. This failure is demonstrated in figs. 1 and 2. All the bolts were correctly tightened during operation, and the postoperative x rays in all cases showed some degree of expansion of the distal end of the nail. Impingement of the rotator cuff in two cases occurred because the nail had not been introduced to the correct depth in the humeral head. In two cases, secondary proximal migration of the nail occurred owing to loosening of the proximal screw. The remaining 4 cases we believe to be caused by the surgical trauma to the subacromial structures during the operation. One radial palsy was caused by reaming of a spiral fracture. One axillary nerve palsy consisted in a denervation of the deltoid muscle anterior to the incision. The six patients with pathological fractures were not reexamined. Four elderly patients with severely displaced fractures had died at the time of reexamination, and one patient with a healed nonunion refused the interview. Consequently, 20 patients were scored according to the Neer score (6), and their personal assessment was recorded as shown in table II.

The seven patients with excellent Neer scores coincided with the six good and acceptable assessments. Six of these were severely displaced fractures, and one a healed nonunion. The lower

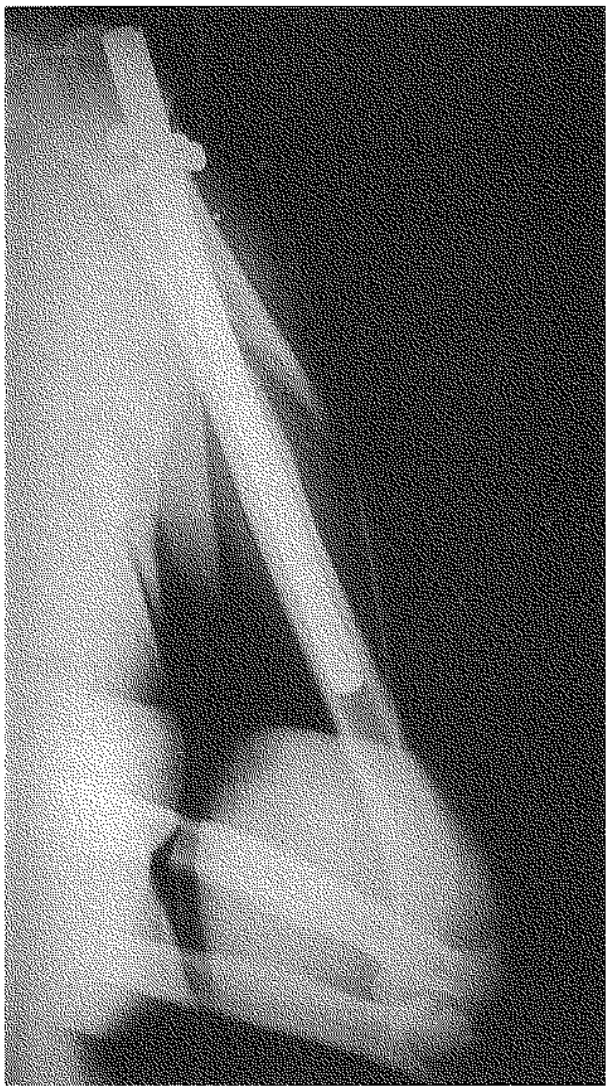

Fig. 1. — Postoperative x-ray showing correct expansion of the distal locking bolt.

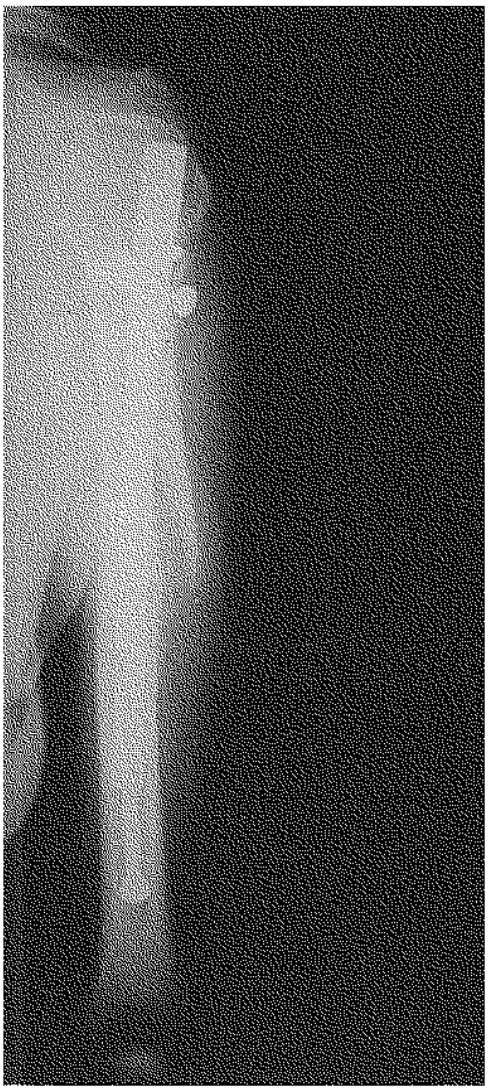

Fig. 2. — Four weeks later. Loosening of the distal expansion bolt.

Table II. — Neer score and personal assessment of 20 reexamined patients

Neer score		Patient's own assessment	
Excellent	7	Good	6
Satisfactory	7	Acceptable	7
Unsatisfactory	2	Dissatisfied	7
Failure	4		

Neer scores and the dissatisfied patients were the patients with refractures, nonunion, nerve palsies, supraspinatus lesions and impingement of the rotator cuff.

DISCUSSION

The Seidel intramedullary humeral nail is introduced at the top of the humerus and is locked distally with an expansion bolt, proximally with

screws (12). Reaming of the humeral canal is often necessary as the nail is 9 mm in diameter (8). Most humeral shaft fractures heal uneventfully (2, 11), and we therefore only used the nail in the three specified categories of patients.

The nailing could be characterized as a limited success in the 6 patients with pathological fractures, as all the patients were relieved of pain until their death despite the fact that none of the fractures healed. We believe the reason the fractures did not heal to be a combination of the metastatic process itself and the relatively short time left for healing to occur. Other authors have reported the same experience (7).

In the nonunion group a healing rate of 3 out of 7 fractures is definitely unsatisfactory.

Far too many complications were encountered. In 10 cases the distal locking bolt dropped into the medullary canal,but in only four patients was this material failure associated with nonunion.

Impingement at the proximal end of the nail was seen in 8 cases, and in 4 of these the nail had to be removed. We have used the exact point of entry for the nail as described by Seidel. In two cases only, the nail had not been introduced to the correct depth in the humeral head. In 4 patients the operation was a total disaster. One patient had a permanent partial axillary nerve palsy ; one a complete radial nerve palsy. In none of these patients was the nerve lesion present before surgery.

In two patients a refracture occurred distally to the nail. We believe these refractures were caused by weakening of the bone due to the reaming procedure. Some of these complications have been reported by other authors (1, 3, 9).

We are aware of the fact that we have selected three difficult categories of patients. All operations were performed by qualified orthopedic surgeons, and we consider the complication rate far too high. Effectively it is the highest rate of complications reported, as seen in table III.

We know that other authors have published good results, especially in the middle and distal third of the humeral diaphysis, with lower complication and failure rates (5). We believe the reasons for our failures and complications are many. The complications can be divided into

Table III. — Comparison of recorded complications using the Seidel nail

Author	N. of patients	Radial palsy	Axillary nerve palsy	Humeral cracks	Diaphyseal fracture	Loosening of the expansion bolt	Sepsis	Nonu-nion	Reop. rate	Failure of proximal locking	Impinge-ment	Poor shoulder function
Barnes	13	0	0	2	1	0	0	1		2	1	
Kempf	41	1 (2%)	1 (2%)	0	0	0	11 (2%)	0	7 (17%)	0	4 (10%)	± 1
Pietu	10					5 (50%)		4 (40%)	1 (10%)		0	
Riemer 1991	42	0	0	1 (2%)			0	7	4 (10%)		4	6
Riemer 1994	36 < 9 mm : 12 > 9 mm : 24			1 (3%)	2 (6%)	7 (19%)	2	3			4	4
Habernek 1991	19	0					0	0	3			0
Robinson 1992	30	1 (3%)	0	3 (10%)		9 (30%)	22	7 (23%)	21 (70%)	8	12	13
Svend-Hansen	31	1 (3%)	1 (3%)		2 (6%)	10 (33%)	1 (3%)	10 (33%)	4 (13%)	2	8	6

surgeon-dependent complications and complications related to the nail.

Two of the impingements resulted from technical errors. The deep infection, radial nerve palsy, supraspinatus lesion and axillary nerve lesion are all complications not specific for the Seidel nail. Loss of fixation, however, caused by loosening of the distal locking bolt, is definitely related to a fault in the design of the nail. The same applies to the two cases of proximal screw loosening. The necessary reaming of the medullary canal may damage the blood supply and definitely weakens the bone, creating a weak spot distally between supported and unsupported bone, especially in patients with narrow humeral canals. This accounts for the two refractures distal to the nail.

We still find intramedullary fixation of humeral fractures to be indicated in selected patients, but we would recommend preoperative x ray planning of the length and diameter of the humeral canal. Different nail diameters should be available, and we would prefer an unreamed nailing procedure and a better locking device.

REFERENCES

1. Barnes C., Shuler T. Complications associated with the Seidel nail. Orthop. Rev., 1993, 22, 699-706.
2. Böhler L. Die Technik der Knochenbruchbehandlung. Vienna, W. Mandrich, 1951.
3. Evans P., Conboy V., Evans E. The Seidel humeral locking nail : an anatomical study of the complications from locking screws. Injury, 1993, 24, 175-176.
4. Habernek H., Orthner E. A locking nail for fractures of the humerus. J. Bone Joint Surg., 1991, 73-B, 651-653.
5. Kempf I., Heckel T., Pidhorz L., Taglang G., Grosse A. L'enclouage verrouillé selon Seidel des fractures diaphysaires humérales récentes. Rev. Chir. Orthop., 1994, 80, 5-13.
6. Neer C. Displaced proximal humeral fractures. J. Bone Joint Surg., 1970, 52-A, 1077-1089.
7. Pietu G., Letenneur J., Bourgade M. Le clou huméral de Seidel dans les indications limites. Fractures pathologiques, retards de consolidations, pseudarthroses et reconstructions. Acta Orthop. Belg., 1994, 60, 187-193.
8. Riemer B., Butterfield S., d'Ambrosia R., Kellam J. Seidel intramedullary nailing of humeral diaphyseal fractures : a preliminary report. Orthopedics, 1991, 14, 239-246.
9. Riemer B., Foglesons M., Burke C., Butterfield S. Complications of Seidel intramedullary nailing of narrow diameter humeral diaphyseal fractures. Orthopedics, 1994, 17, 19-29.
10. Robinson C., Bell K., Court-Brown C., McQueen M. Locked nailing of humeral shaft fractures. Experience in Edinburgh over a two-year period. J. Bone Joint Surg., 1992, 74-B, 558-562.
11. Sarmiento A., Kinman P., Galvin E. Functional bracing of fractures of the shaft of the humerus. J. Bone Joint Surg., 1977, 59-A, 596-601.
12. Seidel H. Humeral locking nail : a preliminary report. Orthopedics, 1989, 12, 219-226.

SAMENVATTING

H. SVEND-HANSEN, M. SKETTRUP, M. W. RATHCKE. Complicaties van de Seidelnagel in een reeks van 31 gevallen.

De auteurs melden hun ervaring met de Seidelnageling in de behandeling van humerusfracturen. Deze implant werd gebruikt voor drie indicaties : pathologische fracturen (6 x), pseudarthrosen (7 x) en fracturen met grote verplaatsing (18 x). Enkel bij pathologische fracturen gaf dit voldoening ; falen en complicaties waren talrijk. Bepaalde complicaties waren onafhankelijk van het materiaal, doch 2 x een proximale loslating en 10 x een distale loslating in de eerste postoperatieve weken hebben de auteurs doen besluiten om af te zien van deze humerusnagel.

RÉSUMÉ

H. SVEND-HANSEN, M. SKETTRUP, M. W. RATHCKE. Complications observées avec le clou huméral de Seidel dans une série de 31 fractures.

Les auteurs rapportent leur expérience du clou de Seidel dans le traitement des fractures humérales. Ce matériel a été utilisé dans trois indications : six fractures pathologiques, sept pseudarthroses, dix-huit fractures à grand déplacement de la diaphyse humérale. Le traitement n'a donné satisfaction que dans le cas des fractures pathologiques. Les taux d'échec et de complication ont été très élevés. Certaines des complications n'étaient pas spécifiques à l'implant utilisé mais d'autres l'étaient, avec perte de la fixation proximale dans 2 cas, de la fixation distale dans 10 cas, dans les semaines qui ont suivi l'opération. Les auteurs ont par conséquent renoncé à utiliser ce clou huméral.